**Claims**

1. An optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, and an array of sub-regions within the core layer having a second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure within the core layer, wherein:

$$n_{rods}-n_{core} > 0.1.$$

2. An optical waveguide structure according to claim 1, wherein the waveguide structure is a planar waveguide structure, the core layer being formed between a cladding layer and a buffer layer, the cladding layer having a third refractive index $n_{cladding}$, and the buffer layer having a fourth refractive index $n_{buffer}$, wherein:

$$n_{rods} > n_{core} > n_{cladding} \text{ and } n_{buffer}.$$

3. An optical waveguide structure according to claim 1, wherein the waveguide structure is an optical fibre, further comprising a cladding layer having a third refractive index $n_{cladding}$, surrounding the core layer, wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$

4. An optical fibre according to claim 3, wherein the cladding layer is planarised in the vicinity of the array of sub-regions, the array of sub-regions extending through the planarised cladding layer and into the core layer.

5. An optical waveguide structure according to claim 1, wherein the array of sub-regions gives rise to a photonic bandgap.

6. An optical waveguide structure according to claim 1, wherein the sub-regions are formed from silicon.

7. An optical waveguide structure according to claim 1, wherein the core layer is formed from silicon nitride, silicon oxynitride, doped silica, tantalum pentoxide or doped tantalum pentoxide.

8. An optical waveguide structure according to claim 2 or 3, wherein the cladding layer is formed from silicon dioxide.

9. A planar optical waveguide structure according to claim 2, wherein the sub-regions extend through the cladding layer as well as the core layer.

10. A planar optical waveguide structure according to claim 2, wherein the sub-regions extend partially into the buffer layer.

11. An optical waveguide structure according to claim 2 or 3, wherein the cladding layer includes sub-regions corresponding to the sub-regions in the core layer, having a refractive index which is greater than or equal to the refractive index of the cladding layer but which is less than or equal to the refractive index of the core.

12. An optical waveguide structure according to claim 1, wherein the array of sub-regions are arranged in a square lattice.

13. An optical waveguide structure according to claim 1, wherein the core layer includes a waveguiding region having no sub-regions.

14. An optical waveguide structure according to claim 10, wherein the waveguiding region includes a bend.

15. An optical device incorporating an optical waveguide structure according to claim 1.

16. A method of manufacturing a optical waveguide structure comprising the steps of:

providing a core layer having a first refractive index $n_{core}$;

forming an array of holes in the core layer extending longitudinally along the waveguide; and

filling the holes with a material having a second refractive index $n_{rods}$, wherein:

$$n_{rods}-n_{core} > 0.1.$$

17. A method according to claim 16, wherein the optical waveguide is a planar waveguide, the method further including the steps of:

providing a buffer layer having a refractive index $n_{buffer}$ on one side of the core layer; and

providing a cladding layer having a refractive index $n_{cladding,}$ on the other side of the core layer, wherein:

$$n_{rods} > n_{core} > n_{cladding} \text{ and } n_{buffer}.$$

18. A method according to claim 16, wherein the optical waveguide is an optical fibre, the method further including the steps of:

providing a cladding layer having a refractive index $n_{cladding,}$ surrounding the core layer, wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$

19. A method of guiding an optical signal comprising the step of passing an optical signal through a waveguiding region of an optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, and an array of sub-regions within the core layer extending longitudinally along the waveguide having a second refractive index, $n_{rods}$, the array of sub-regions giving rise to a photonic band structure within the core layer, wherein:

$$n_{rods}\text{-}n_{core} > 0.1..$$

20. A method according to claim 19, wherein the waveguide is a planar waveguide, wherein the core layer is formed between a cladding layer and a buffer layer, the cladding layer having a third refractive index $n_{cladding}$, and the buffer layer having a fourth refractive index $n_{buffer}$, and wherein:

$$n_{rods} > n_{core} > n_{cladding} \text{ and } n_{buffer.}$$

21. A method according to claim 19, wherein the optical waveguide is an optical fibre, wherein a cladding layer has a third refractive index $n_{cladding}$, and surrounds the core layer, and wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$

22. An optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, and a 2-dimensional array of sub-regions within the core layer having a

second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure within the core layer, wherein:

$$n_{rods} > n_{core}.$$

23. An optical waveguide structure according to claim 22, wherein $n_{rods}-n_{core} > 0.1$.

24. An optical waveguide structure according to claim 22 or 23, wherein the waveguide structure is a planar waveguide structure, the core layer being formed between a cladding layer and a buffer layer, the cladding layer having a third refractive index $n_{cladding}$, and the buffer layer having a fourth refractive index $n_{buffer}$, wherein:

$$n_{rods} > n_{core} > n_{cladding} \text{ and } n_{buffer}.$$

25. An optical waveguide structure according to any one of claims 22-24, wherein the waveguide structure is an optical fibre, further comprising a cladding layer having a third refractive index $n_{cladding}$, surrounding the core layer, wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$

26. A method of manufacturing a optical waveguide structure comprising the steps of:

providing a core layer having a first refractive index $n_{core}$;

forming a 2-dimensional array of holes in the core layer extending longitudinally along the waveguide structure;

filling the holes with a material having a second refractive index $n_{rods}$, wherein:

$$n_{rods} > n_{core}.$$

27. A method according to claim 26, wherein $n_{rods}-n_{core} > 0.1$.

28. A method according to claim 26 or 27, wherein the optical waveguide is a planar waveguide, the method further including the steps of:

providing a buffer layer having a refractive index $n_{buffer}$ on one side of the core layer; and

providing a cladding layer having a refractive index $n_{cladding}$, on the other side of the core layer, wherein:

$n_{rods} > n_{core} > n_{cladding}$ and $n_{buffer}$.

**29.** A method according to any one of claims 26-28, wherein the optical waveguide is an optical fibre, the method further including the steps of:

providing a cladding layer having a refractive index $n_{cladding}$, surrounding the core layer, wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$

30. A method of guiding an optical signal comprising the step of passing an optical signal through a waveguiding region of an optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, and a 2-dimensional array of sub-regions within the core layer extending longitudinally along the waveguide having a second refractive index $n_{rods}$, the array of sub-regions giving rise to a photonic band structure within the core layer, wherein:

$$n_{rods} > n_{core}.$$

31. A method according to claim 30, wherein $n_{rods}-n_{core} > 0.1$.

32. A method according to claim 30 or 31, wherein the waveguide is a planar waveguide, wherein the core layer is formed between a cladding layer and a buffer layer, the cladding layer having a third refractive index $n_{cladding}$, and the buffer layer having a fourth refractive index $n_{buffer}$, and wherein:

$$n_{rods} > n_{core} > n_{cladding} \text{ and } n_{buffer}.$$

33. A method according to any one of claims 30-32, wherein the optical waveguide is an optical fibre, wherein a cladding layer has a third refractive index $n_{cladding}$, and surrounds the core layer, and wherein:

$$n_{rods} > n_{core} > n_{cladding}.$$